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(56)参考文献　特開　昭64－17820（ＪＰ，Ａ）
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実開　昭58－19462（ＪＰ，Ｕ）

(54)【発明の名称】　高靭性熱処理用電縫鋼管

1

(57)【特許請求の範囲】

【請求項１】重量%で、C:0.10～0.30%、Si:0.05～0.50%、Mn:0.40～1.40%、Al:0.005～0.050%、Nb:0.005～0.050%を含有し、残部がFeおよび不可避不純物からなり、不純物中のＰが0.025%以下、Ｓが0.010%以下、Ｏが0.0010%以下である、熱処理によって優れた低温靭性を有する熱処理用電縫鋼管。

【請求項２】請求項（１）記載の成分に加え、さらに、重量%で、Cr:0.05～0.50%、Mo:0.05～0.50%、Ti:0.005～0.050%（ただし、Ti≧3.4N%）、B:0.0010～0.0050%の１種以上を含有し、残部がFeおよび不可避不純物からなり、不純物中のＰが0.025%以下、Ｓが0.010%以下、Ｏが0.0010%以下である、熱処理によって優れた低温靭性を有する熱処理用電縫鋼管。

【発明の詳細な説明】

2

（産業上の利用分野）

本発明は、熱処理を施すことにより高い強度と靭性を付与することができる高靭性熱処理用電縫鋼管に関する。

（従来の技術）

熱処理用電縫鋼管は、自動車の懸架機構部に用いられる中空スタビライザーなど機械構造用の部材として多用される傾向にあり、また近年、自動車の軽量化の動向に対応して鋼管製ドア補強材の開発が進んでいる。このドア補強材は、側面衝突時の乗員の保護を目的としてドアの内部に設置される。このような用途に使用される鋼管は、成形加工の前は低強度で加工性に優れている必要があり、成形加工後の熱処理によって、例えば150kgf/mm²級までの高強度になることが求められる傾向にあり、さらに、衝突時の突発的な応力負荷に対しても脆性的な折

損が生じないよう十分な靭性を有していることが必要とされる。例えば、特開昭64－4424号公報、特開昭64－17820号公報には加工性の優れた熱処理用電縫鋼管の製造方法が提案されている。

（発明が解決しようとする課題）

本発明は、製管までの状態では低強度で加工性に優れ、加工後の熱処理によって、高強度と優れた低温靭性を有するに到る熱処理用電縫鋼管を提供することを目的とする。

（課題を解決するための手段）

本発明者は、種々検討を重ねた結果、焼入れ処理後に高強度ならびに高靭性を有する電縫鋼管を得るためには、鋼に適量のNbを含有させ、O（酸素）含有量を極力低く抑えることが必要であることを確認した。本発明はこの知見に基づいて成されたもので、その要旨は下記①および②の電縫鋼管にある（以下、「％」はすべて重量％を意味する）。

① 重量％で、C:0.10～0.30％、Si:0.05～0.50％、Mn:0.41～1.40％、Al:0.005～0.050％、Nb:0.005～0.050％を含有し、残部がFeおよび不可避不純物からなり、不純物中のPが0.025％以下、Sが0.010％以下、Oが0.0010％以下である、熱処理によって優れた低温靭性を有する熱処理用電縫鋼管。

② 前記①記載の成分に加え、さらに、重量％で、Cr:0.05～0.50％、Mo:0.05～0.50％、Ti:0.005～0.050％（ただし、Ti≧3.4N％）、B:0.0010～0.0050％の１種以上を含有し、残部がFeおよび不可避不純物からなり、不純物中のPが0.025％以下、Sが0.010％以下、Oが0.0010％以下である、熱処理によって優れた低温靭性を有する熱処理用電縫鋼管。

（作用）

以下、本発明の熱処理用電縫鋼管を構成する鋼に含まれる各成分の作用効果とそれらの含有量の限定理由について述べる。

Cは熱処理後の電縫鋼管の強度を高める元素である。しかし、その含有量が0.10％未満では強度の確保が不十分であり、また、0.30％を超えると製管のまま（熱処理前）での強度が高くなり過ぎ、加工性に乏しくなる。これらの理由からCの適正含有量は0.10～0.30％である。

Siは製鋼時の脱酸剤として必要不可欠の元素であるが、0.05％未満では十分な効果は得られず、一方、含有量が0.50％を超えると製管時の溶接性が劣化する。

Mnは強度を高める元素であるが、含有量が0.40％未満では機械構造用部材としての強度が不十分であり、一方、1.40％を超えると熱処理前の強度が高くなり過ぎて加工が困難となり、また、溶接性にも悪影響を及ぼす。

Alは鋼の脱酸に用いる元素であるが、含有量が0.005％未満では脱酸効果は少なく、一方、0.050％を超えると鋼の焼入れ性が劣化する。

Nbは微量含有させることにより鋼の強度を大幅に上昇

させる効果を有するが、含有量が0.005％未満ではその効果は十分ではなく、一方、0.050％を超えると効果が飽和することから、Nb含有量は0.005～0.050％とした。

前記①の発明の鋼は、上記の成分以外、残部がFeと不可避の不純物からなるものである。不純物としては、P、S、およびO（酸素）の上限を抑えることが重要である。

P、Sは鋼の熱間での加工性を向上させるために極力低減させることが望ましく、その上限を、Pについては0.025％、Sについては0.010％とした。

Oは150kgf/mm²級の高強度材の靭性を大きく影響する。靭性を向上させるためには、その含有量を極力低減させる必要があり、－40～－60℃程度の寒冷地での使用を考慮して、その上限を0.0010％とした。

②の発明の鋼は、①の発明の鋼に、さらにCr、Mo、TiおよびBのうち１種以上をそれぞれ所定量加えた鋼である。

CrおよびMoの鋼の強度および靭性を向上させる元素であるが、いずれも含有量が0.05％未満ではその効果は小さく、一方、0.50％を超えると効果は飽和する。従って、CrおよびMoの含有量は0.05～0.050％とした。

TiはNbと同様に、微量含有させることにより鋼の強度を大幅に上昇させる効果を有する。しかし、その含有量が0.005％未満ではその効果は小さく、一方、0.050％を超えると効果は飽和する。なお、固溶Nが鋼中に存在するとBと結びついて焼き入れ性を劣化させるので、このNをTiNとして固定するために鋼中のNと等モルのTiを含有させるとして、Tiの含有量をTi≧3.4N％とする（係数の3.4はNの原子量に対するTiの原子量の比である）。従って、Ti含有量は0.005～0.050％で、かつTi≧3.4N％とした。

BはNbおよびTiと同様に微量含有させることにより鋼の強度を大幅に上昇させる効果を有する。しかし、含有量が0.0010％未満ではその効果は小さく、一方、0.0050％を超えると効果は飽和する。従って、B含有量は0.0010～0.0050％とする。

本発明の電縫鋼管を製造するには、上記の各成分を含有する鋼を熱間圧延により鋼帯とした後、この鋼帯を管状に成形し、その両エッジをERW法により溶接して鋼管（ERW鋼管）とすればよい。この鋼管のままのERW鋼管は、引張強さが約65kgf/mm²であり、通常行われる成形加工には十分に耐えることができる。

この鋼管は、ユーザー（機械メーカー）側で所定形状の機械部材に成形加工され、その後焼入れ処理が施されて高強度と高靭性をもつに到る。焼入れ処理は細粒材を得るため短時間加熱とするのが好ましい。例えば、高周波誘導加熱もしくは直接通電加熱（加熱温度は850℃～950℃）の後水冷する焼入れ法が推奨される。このような焼入れのままで使用してもよいが、150～350℃で低温焼もどし処理を施して、焼入れ時の歪みを除去して用いて

もよい。

（実施例）

第１表に示す化学組成を有する鋼を熱間圧延により鋼帯とした後、これを管状に成形し、ERW鋼管とした。この状態での引張強さ（熱処理前の引張強さ）を第１表に併せ示す。

この鋼管を高周波加熱（900℃×20秒保持）後水冷（焼入れ）した後、および焼入れ後250℃で20分間加熱後空冷する焼もどしを行った後、引張試験（降伏点および引張強さを測定）と切欠き付き鋼管の低温落重試験を行った。

低温落重試験では、中央部に1mm深さの切欠きをつけた試験片を所定の温度に冷やして、切欠きを下にして水平に支持し、中央部に高さ2mから重さ90kgの重錘を落下

させることにより瞬間的（衝撃的）に応力を負荷し、試験片が脆性的な折損を生ずるか否かを判定した。

試験結果を第１表に併せ示す。熱処理前の引張強さ、熱処理後の降伏点と引張強さ、および低温落重試験の欄において、上段は焼入れまま材、下段は焼入れ後250℃焼もどし材についての結果である。また、低温落重試験の欄において、○印は鋼管試験片が延性変形したことを、×印は鋼管試験片が脆性的に折損したことをあらわす。

第１表の結果から、本発明の鋼管は、熱処理を施すことにより引張強さが著しく増大し、150kgf/mm²を超える高強度を有するとともに、－100℃でも脆性的な折損を生ずることなく、優れた低温靭性を示すことがわかる。

第　1　表

	No.	管寸法 (mm)	化学成分*(重量%) C	Si	Mn	P	S	Cr	Mo	Nb	Ti	B	Al	N	O	熱処理前 引張強さ (kgf/mm²)	熱処理後 降伏点 (kgf/mm²)	熱処理後 引張強さ (kgf/mm²)	低温落重試験 −60℃	低温落重試験 −100℃
本発明例	1	31.8φ×2.0t	0.21	0.18	0.70	0.015	0.004	−	−	0.026	−	−	0.03	0.005	0.0008	65	110	154	○	○
	2															64	121	150	○	○
	3	31.8φ×3.2t	〃	〃	〃	〃	〃	0.3	−	〃	−	−	〃	〃	〃	65	109	154	○	○
	4															65	120	150	○	○
	5	31.8φ×3.2t	〃	〃	〃	〃	〃	0.2	0.2	〃	−	−	〃	〃	〃	64	111	155	○	○
	6															64	122	150	○	○
	7	31.8φ×2.0t	〃	〃	〃	〃	〃	−	−	〃	0.03	−	〃	〃	〃	65	110	154	○	○
	8															65	121	151	○	○
	9	31.8φ×3.2t	〃	〃	〃	〃	〃	−	−	〃	0.03	0.0015	〃	〃	〃	64	112	155	○	○
	10															63	122	151	○	○
	11	31.8φ×3.2t	〃	〃	〃	〃	〃	0.3	−	〃	0.03	0.0015	〃	〃	〃	63	109	156	○	○
	12															65	123	152	○	○
比較例	13	31.8φ×2.0t	〃	〃	〃	〃	〃	−	−	〃	−	−	〃	〃	0.0012**	63	109	154	○	×
	14															64	121	150	○	×
	15	31.8φ×2.0t	〃	〃	〃	〃	〃	−	−	〃	−	−	〃	〃	0.0020**	65	110	155	×	×
	16															63	118	151	×	×
	17	31.8φ×3.2t	〃	〃	〃	〃	〃	0.3	−	〃	0.03	0.0015	〃	〃	0.0012**	63	111	155	○	×
	18															64	122	152	○	×
	19	31.8φ×3.2t	〃	〃	〃	〃	〃	0.3	−	〃	0.03	0.0015	〃	〃	0.0020**	64	109	156	×	×
	20															65	121	152	×	×

＊　残部はFeおよび不可避不純物

＊＊　本発明の範囲外

試験結果の上段は焼入れまま材、下段は焼入れ後250℃焼きもどし材である。

（発明の効果）

本発明の熱処理用電縫鋼管は、熱処理を施すことによ り高強度を有するとともに高い靭性を示し、特に、近年開発が進みつつある自動車の鋼管製ドア補強材として、

あるいはその他の機械構造用部材として好適な鋼管である。

* NOTICES *

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CLAIMS

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(57) [Claim(s)]
[Claim 1] The electroseamed steel pipe for heat treatment with which P in an impurity has [S / O] the low-temperature toughness which is 0.0010% or less, and which was excellent with heat treatment 0.010% or less 0.025% or less by containing C:0.10 - 0.30%, Si:0.05-0.50%, Mn:0.40-1.40%, aluminum:0.005-0.050%, and Nb:0.005-0.050%, and the remainder consisting of Fe and an unescapable impurity by weight %.
[Claim 2] It adds to a component given in a claim (1). By weight % further Cr:0.05-0.50%, Mo: 0.05-0.50%, Ti:0.005-0.050% (However, Ti>=3.4N%) and B:0.0010 - 0.0050% of one or more sorts are contained. The electroseamed steel pipe for heat treatment with which P in an impurity has [S / O] the low-temperature toughness which is 0.0010% or less, and which was excellent with heat treatment 0.010% or less 0.025% or less by the remainder consisting of Fe and an unescapable impurity.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
(Field of the invention on industry)
This invention relates to the electroseamed steel pipe for high toughness heat treatment which can give high reinforcement and high toughness by heat-treating.
(Prior art)
The electroseamed steel pipe for heat treatment is in the inclination used abundantly as a member of a machines structural steel worker, such as a hollow stabilizer used for the suspension device section of an automobile, and development of the door reinforcing materials made from a steel pipe is progressing in recent years corresponding to the trend of lightweight-izing of an automobile. This door reinforcing materials are installed in the interior of a door for the purpose of protection of the crew at the time of a side collision. To have sufficient toughness so that it is necessary to excel in workability with low strength before the fabricating operation, it may be in the inclination searched for to become the high intensity to the 2nd 150 kgf(s)/mm class by heat treatment after a fabricating operation and brittleness-breakage may not produce further the steel pipe used for such an application to the sudden stress load at the time of a collision is needed. For example, the manufacture approach of the electroseamed steel pipe for heat treatment which was excellent in workability is proposed by JP,64-4424,A and JP,64-17820,A.
(Technical problem which invention tends to solve)
In the condition to tube manufacturing, this invention is excellent in workability with low strength, and aims at offering [which comes to have the outstanding low-temperature toughness with high intensity] the electroseamed steel pipe for heat treatment by heat treatment after processing.
(The means for solving a technical problem)
As a result of repeating various examination, in order to obtain the electroseamed steel pipe which has high intensity and high toughness after hardening processing, this invention person made steel contain Nb of optimum dose, and checked that it was required to stop O (oxygen) content low as much as possible. This invention was accomplished based on this knowledge, and that summary is in the electroseamed steel pipe of the following ** and ** (weight % is meant all"%" hereafter).
** The electroseamed steel pipe for heat treatment with which P in an impurity has [S / O] the low-temperature toughness which is 0.0010% or less, and which was excellent with heat treatment 0.010% or less 0.025% or less by containing C:0.10 - 0.30%, Si:0.05-0.50%, Mn:0.41-1.40%, aluminum:0.005-0.050%, and Nb:0.005-0.050%, and the remainder consisting of Fe and an unescapable impurity by weight %.
It adds to a component given [aforementioned] in **. By weight % further ** Cr:0.05-0.50%, Mo: 0.05-0.50%, Ti:0.005-0.050% (However, Ti>=3.4N%) and B:0.0010 - 0.0050% of one or more sorts are contained. The electroseamed steel pipe for heat treatment with which P in an impurity has [S / O] the low-temperature toughness which is 0.0010% or less, and which was excellent with heat treatment 0.010% or less 0.025% or less by the remainder consisting of Fe and an unescapable impurity.

(Operation)
The operation effectiveness of each component hereafter contained in the steel which constitutes the electroseamed steel pipe for heat treatment of this invention, and the reason for definition of those contents are explained.
C is an element which raises the reinforcement of the electroseamed steel pipe after heat treatment. However, if less than 0.10% of strong reservation is [the content] insufficient and it exceeds 0.30%, reinforcement with tube manufacturing (before heat treatment) will become high too much, and will become scarce at workability. The proper content of these reasons to C is 0.10 - 0.30%.
Although Si is an indispensable element as a deoxidizer at the time of steel manufacture, effectiveness sufficient at less than 0.05% is not acquired, but if a content exceeds 0.50%, on the other hand, the weldability at the time of tube manufacturing will deteriorate.
Although Mn is an element which raises reinforcement, if the reinforcement as a machine structural element has an inadequate content at less than 0.40% and it exceeds 1.40% on the other hand, the reinforcement before heat treatment will become high too much, and processing will become difficult, and it will have an adverse effect also on weldability.
Although aluminum is an element used for deoxidation of steel, if the deoxidation effectiveness has few contents at less than 0.005% and they exceed 0.050% on the other hand, the hardenability of steel will deteriorate.
Although Nb had the effectiveness of raising the reinforcement of steel substantially by carrying out minute amount content, since effectiveness was saturated when less than 0.005% of the effectiveness exceeded 0.050% on the other hand rather than it was enough as the content, Nb content was made into 0.005 - 0.050%.
The steel of invention of the aforementioned ** consists of an impurity with the as unescapable remainder as Fe except the above-mentioned component. As an impurity, it is important to suppress the upper limit of P, S, and O (oxygen).
In order that P and S might raise the workability between the heat of steel, it was desirable to make it decrease as much as possible, and they made [P] the upper limit 0.010% about S 0.025%.
O influences greatly the toughness of 150 kgf(s)/mm high intensity material of the 2nd class. In order to raise toughness, the content needed to be reduced as much as possible, and the upper limit was made into 0.0010% in consideration of the activity in the cold district which is about - 40--60 degree C.
** The steel of invention is specified quantity ******** further at the steel of invention of **, respectively about one or more sorts in Cr, Mo, Ti, and B.
Although it is the element which raises the reinforcement and the toughness of steel of Cr and Mg, effectiveness will be saturated, if the effectiveness has a small content at less than 0.05% and all exceed 0.50% on the other hand. Therefore, the content of Cr and Mo was made into 0.05 - 0.050%.
Ti has the effectiveness of raising the reinforcement of steel substantially by carrying out minute amount content like Nb. However, the content of the effectiveness is small at less than 0.005%, and on the other hand, if it exceeds 0.050%, effectiveness will be saturated. In addition, the content of Ti is made into Ti>=3.4N% noting that N in steel and Ti of equimolar are made to contain since it will be connected with B and hardenability will be degraded, if Dissolution N exists in steel, since this N is fixed as TiN (3.4 of a multiplier is the ratio of the atomic weight of Ti to the atomic weight of N). Therefore, Ti content is 0.005 - 0.050%, and was made into Ti>=3.4N%.
B has the effectiveness of raising the reinforcement of steel substantially, by carrying out minute amount content like Nb and Ti. However, at less than 0.0010%, the effectiveness has a small content, and on the other hand, if it exceeds 0.0050%, effectiveness will be saturated. Therefore, B content is made into 0.0010 - 0.0050%.
this steel strip in order to manufacture the electroseamed steel pipe of this invention, after making steel containing each above-mentioned component into a steel strip with hot rolling -- the shape of tubing -- fabricating -- both that edge -- ERW -- law -- welding -- a steel pipe

(ERW steel pipe) — then, it is good. Tensile strength is 2 about 65 kgf(s)/mm, and the ERW steel pipe with this steel pipe can fully be borne at the fabricating operation usually performed.
The fabricating operation of this steel pipe is carried out to the machine member of a predetermined configuration by the user (machine builder) side, hardening processing is performed after that and it comes to have high intensity and high toughness. As for hardening processing, considering as short-time heating is desirable in order to obtain fine grain material. For example, the hardening process high-frequency induction heating or direct energization heating (whenever [stoving temperature] is 850 degrees C - 950 degrees C) carries out [a hardening process] after water cooling is recommended. Although you may use it with such hardening, low-temperature tempering processing may be performed at 150-350 degrees C, and the distortion at the time of hardening may be removed and used.
(Example)
After making into a steel strip steel which has the chemical composition shown in the 1st table with hot rolling, this was fabricated in the shape of tubing, and it considered as the ERW steel pipe. The tensile strength (tensile strength before heat treatment) in this condition is combined and shown in the 1st table.
After carrying out after [high-frequency heating (900 degree-Cx 20 second maintenance)] water cooling (hardening) of this steel pipe, and after performing tempering which carries out after [heating] air cooling for 20 minutes at 250 degrees C after hardening, the tension test (the yield point and tensile strength are measured) and the low-temperature drop weight test of a steel pipe with a notch were performed.
cooling the test piece which attached the notch of 1mm depth to the center section to predetermined temperature in a low-temperature drop weight test, turning a notch down, supporting horizontally, and dropping a weight with a weight of 90kg from height of 2m in the center section — being momentary (shocking) — the load of the stress was carried out and it judged whether a test piece would produce brittleness-breakage.
A test result is combined and shown in the 1st table. In the column of the tensile strength before heat treatment, the yield point after heat treatment and tensile strength, and a low-temperature drop weight test, as [hardening], an upper case is material and the lower berth is a result about after [hardening] 250-degree-C tempering material. Moreover, in the column of a low-temperature drop weight test, a steel pipe test piece means having broken that the steel pipe test piece carried out ductility deformation of the O mark in [x mark] brittleness.
It turns out that the outstanding low-temperature toughness is shown, without producing at least -100 degrees C of brittleness-breakages, while having the high intensity to which tensile strength increases remarkably and exceeds 2 150 kgf/mm when the steel pipe of the result of the 1st table to this invention heat-treats.

第　　1　　表

	No.	管寸法 (mm)	化学成分*(重量%) C	Si	Mn	P	S	Cr	Mo	Nb	Ti	B	Al	N	O	熱処理前 引張強さ (kgf/mm²)	熱処理後 降伏点 (kgf/mm²)	熱処理後 引張強さ (kgf/mm²)	低温落重試験 −60℃	低温落重試験 −100℃
本発明例	1	31.8φ×2.0t	0.21	0.18	0.70	0.015	0.004	—	—	0.026	—	—	0.03	0.005	0.0008	65	110	154	○	○
	2															64	121	150	○	○
	3	31.8φ×3.2t	〃	〃	〃	〃	〃	0.3	—	〃	—	—	〃	〃	〃	65	109	154	○	○
	4															65	120	150	○	○
	5	31.8φ×3.2t	〃	〃	〃	〃	〃	0.2	0.2	〃	—	—	〃	〃	〃	64	111	155	○	○
	6															64	122	150	○	○
	7	31.8φ×2.0t	〃	〃	〃	〃	〃	—	—	〃	0.03	—	〃	〃	〃	65	110	154	○	○
	8															65	121	151	○	○
	9	31.8φ×3.2t	〃	〃	〃	〃	〃	—	—	〃	0.03	0.0015	〃	〃	〃	64	112	155	○	○
	10															63	122	151	○	○
	11	31.8φ×3.2t	〃	〃	〃	〃	〃	0.3	—	〃	0.03	0.0015	〃	〃	〃	63	109	156	○	○
	12															65	123	152	○	○
比較例	13	31.8φ×2.0t	〃	〃	〃	〃	〃	—	—	〃	—	—	〃	〃	0.0012**	63	109	154	○	×
	14															64	121	150	○	×
	15	31.8φ×2.0t	〃	〃	〃	〃	〃	—	—	〃	—	—	〃	〃	0.0020**	65	110	155	×	×
	16															63	118	151	×	×
	17	31.8φ×3.2t	〃	〃	〃	〃	〃	0.3	—	〃	0.03	0.0015	〃	〃	0.0012**	63	111	155	○	×
	18															64	122	152	○	×
	19	31.8φ×3.2t	〃	〃	〃	〃	〃	0.3	—	〃	0.03	0.0015	〃	〃	0.0020**	64	109	156	×	×
	20															65	121	152	×	×

＊　残部はFeおよび不可避不純物

＊＊　本発明の範囲外

試験結果の上段は焼入れまま材、下段は焼入れ後250℃焼きもどし材である。

(Effect of the invention)

The electroseamed steel pipe for heat treatment of this invention is a steel pipe suitable as the door reinforcing materials made from a steel pipe of the automobile to which high toughness is shown while having high intensity by heat-treating, and development is going especially in recent

years, or other machine structural elements.

[Translation done.]

* NOTICES *

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TECHNICAL FIELD

(Field of the invention on industry)
This invention relates to the electroseamed steel pipe for high toughness heat treatment which can give high reinforcement and high toughness by heat-treating.

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PRIOR ART

(Prior art)
The electroseamed steel pipe for heat treatment is in the inclination used abundantly as a member of a machines structural steel worker, such as a hollow stabilizer used for the suspension device section of an automobile, and development of the door reinforcing materials made from a steel pipe is progressing in recent years corresponding to the trend of lightweight-izing of an automobile. This door reinforcing materials are installed in the interior of a door for the purpose of protection of the crew at the time of a side collision. To have sufficient toughness so that it is necessary to excel in workability with low strength before the fabricating operation, it may be in the inclination searched for to become the high intensity to the 2nd 150 kgf(s)/mm class by heat treatment after a fabricating operation and brittleness-breakage may not produce further the steel pipe used for such an application to the sudden stress load at the time of a collision is needed. For example, the manufacture approach of the electroseamed steel pipe for heat treatment which was excellent in workability is proposed by JP,64-4424,A and JP,64-17820,A.

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EFFECT OF THE INVENTION

(Effect of the invention)
The electroseamed steel pipe for heat treatment of this invention is a steel pipe suitable as the door reinforcing materials made from a steel pipe of the automobile to which high toughness is shown while having high intensity by heat-treating, and development is going especially in recent years, or other machine structural elements.

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TECHNICAL PROBLEM

(Technical problem which invention tends to solve)
In the condition to tube manufacturing, this invention is excellent in workability with low strength, and aims at offering [which comes to have the outstanding low-temperature toughness with high intensity] the electroseamed steel pipe for heat treatment by heat treatment after processing.

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MEANS

(The means for solving a technical problem)
As a result of repeating various examination, in order to obtain the electroseamed steel pipe which has high intensity and high toughness after hardening processing, this invention person made steel contain Nb of optimum dose, and checked that it was required to stop O (oxygen) content low as much as possible. This invention was accomplished based on this knowledge, and that summary is in the electroseamed steel pipe of the following ** and ** (weight % is meant all"%" hereafter).
** The electroseamed steel pipe for heat treatment with which P in an impurity has [S / O] the low-temperature toughness which is 0.0010% or less, and which was excellent with heat treatment 0.010% or less 0.025% or less by containing C:0.10 - 0.30%, Si:0.05-0.50%, Mn:0.41-1.40%, aluminum:0.005-0.050%, and Nb:0.005-0.050%, and the remainder consisting of Fe and an unescapable impurity by weight %.
It adds to a component given [aforementioned] in **. By weight % further ** Cr:0.05-0.50%, Mo:0.05-0.50%, Ti:0.005-0.050% (However, Ti>=3.4N%) and B:0.0010 - 0.0050% of one or more sorts are contained. The electroseamed steel pipe for heat treatment with which P in an impurity has [S / O] the low-temperature toughness which is 0.0010% or less, and which was excellent with heat treatment 0.010% or less 0.025% or less by the remainder consisting of Fe and an unescapable impurity.

[Translation done.]

* NOTICES *

OPERATION

(Operation)
The operation effectiveness of each component hereafter contained in the steel which constitutes the electroseamed steel pipe for heat treatment of this invention, and the reason for definition of those contents are explained.
C is an element which raises the reinforcement of the electroseamed steel pipe after heat treatment. However, if less than 0.10% of strong reservation is [the content] insufficient and it exceeds 0.30%, reinforcement with tube manufacturing (before heat treatment) will become high too much, and will become scarce at workability. The proper content of these reasons to C is 0.10 - 0.30%.
Although Si is an indispensable element as a deoxidizer at the time of steel manufacture, effectiveness sufficient at less than 0.05% is not acquired, but if a content exceeds 0.50%, on the other hand, the weldability at the time of tube manufacturing will deteriorate.
Although Mn is an element which raises reinforcement, if the reinforcement as a machine structural element has an inadequate content at less than 0.40% and it exceeds 1.40% on the other hand, the reinforcement before heat treatment will become high too much, and processing will become difficult, and it will have an adverse effect also on weldability.
Although aluminum is an element used for deoxidation of steel, if the deoxidation effectiveness has few contents at less than 0.005% and they exceed 0.050% on the other hand, the hardenability of steel will deteriorate.
Although Nb had the effectiveness of raising the reinforcement of steel substantially by carrying out minute amount content, since effectiveness was saturated when less than 0.005% of the effectiveness exceeded 0.050% on the other hand rather than it was enough as the content, Nb content was made into 0.005 - 0.050%.
The steel of invention of the aforementioned ** consists of an impurity with the as unescapable remainder as Fe except the above-mentioned component. As an impurity, it is important to suppress the upper limit of P, S, and O (oxygen).
In order that P and S might raise the workability between the heat of steel, it was desirable to make it decrease as much as possible, and they made [P] the upper limit 0.010% about S 0.025%.
O influences greatly the toughness of 150 kgf(s)/mm high intensity material of the 2nd class. In order to raise toughness, the content needed to be reduced as much as possible, and the upper limit was made into 0.0010% in consideration of the activity in the cold district which is about -40--60 degree C.
** The steel of invention is specified quantity ******** further at the steel of invention of **, respectively about one or more sorts in Cr, Mo, Ti, and B.
Although it is the element which raises the reinforcement and the toughness of steel of Cr and Mg, effectiveness will be saturated, if the effectiveness has a small content at less than 0.05% and all exceed 0.50% on the other hand. Therefore, the content of Cr and Mo was made into 0.05 - 0.050%.
Ti has the effectiveness of raising the reinforcement of steel substantially by carrying out minute amount content like Nb. However, the content of the effectiveness is small at less than 0.005%,

and on the other hand, if it exceeds 0.050%, effectiveness will be saturated. In addition, the content of Ti is made into Ti>=3.4N% noting that N in steel and Ti of equimolar are made to contain since it will be connected with B and hardenability will be degraded, if Dissolution N exists in steel, since this N is fixed as TiN (3.4 of a multiplier is the ratio of the atomic weight of Ti to the atomic weight of N). Therefore, Ti content is 0.005 - 0.050%, and was made into Ti>=3.4N%.

B has the effectiveness of raising the reinforcement of steel substantially, by carrying out minute amount content like Nb and Ti. However, at less than 0.0010%, the effectiveness has a small content, and on the other hand, if it exceeds 0.0050%, effectiveness will be saturated. Therefore, B content is made into 0.0010 - 0.0050%.

this steel strip in order to manufacture the electroseamed steel pipe of this invention, after making steel containing each above-mentioned component into a steel strip with hot rolling — the shape of tubing — fabricating — both that edge — ERW — law — welding — a steel pipe (ERW steel pipe) — then, it is good. Tensile strength is 2 about 65 kgf(s)/mm; and the ERW steel pipe with this steel pipe can fully be borne at the fabricating operation usually performed.

The fabricating operation of this steel pipe is carried out to the machine member of a predetermined configuration by the user (machine builder) side, hardening processing is performed after that and it comes to have high intensity and high toughness. As for hardening processing, considering as short-time heating is desirable in order to obtain fine grain material. For example, the hardening process high-frequency induction heating or direct energization heating (whenever [stoving temperature] is 850 degrees C - 950 degrees C) carries out [a hardening process] after water cooling is recommended. Although you may use it with such hardening, low-temperature tempering processing may be performed at 150-350 degrees C, and the distortion at the time of hardening may be removed and used.

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EXAMPLE

(Example)
After making into a steel strip steel which has the chemical composition shown in the 1st table with hot rolling, this was fabricated in the shape of tubing, and it considered as the ERW steel pipe. The tensile strength (tensile strength before heat treatment) in this condition is combined and shown in the 1st table.
After carrying out after [high-frequency heating (900 degree-Cx 20 second maintenance)] water cooling (hardening) of this steel pipe, and after performing tempering which carries out after [heating] air cooling for 20 minutes at 250 degrees C after hardening, the tension test (the yield point and tensile strength are measured) and the low-temperature drop weight test of a steel pipe with a notch were performed.
cooling the test piece which attached the notch of 1mm depth to the center section to predetermined temperature in a low-temperature drop weight test, turning a notch down, supporting horizontally, and dropping a weight with a weight of 90kg from height of 2m in the center section -- being momentary (shocking) -- the load of the stress was carried out and it judged whether a test piece would produce brittleness-breakage.
A test result is combined and shown in the 1st table. In the column of the tensile strength before heat treatment, the yield point after heat treatment and tensile strength, and a low-temperature drop weight test, as [hardening], an upper case is material and the lower berth is a result about after [hardening] 250-degree-C tempering material. Moreover, in the column of a low-temperature drop weight test, a steel pipe test piece means having broken that the steel pipe test piece carried out ductility deformation of the O mark in [x mark] brittleness.
It turns out that the outstanding low-temperature toughness is shown, without producing at least -100 degrees C of brittleness-breakages, while having the high intensity to which tensile strength increases remarkably and exceeds 2 150 kgf/mm when the steel pipe of the result of the 1st table to this invention heat-treats.

第 1 表

	No.	管寸法 (mm)	化学成分*(重量%) C	Si	Mn	P	S	Cr	Mo	Nb	Ti	B	Al	N	O	熱処理前 引張強さ (kgf/mm²)	熱処理後 降伏点 (kgf/mm²)	熱処理後 引張強さ (kgf/mm²)	低温落重試験 −60℃	低温落重試験 −100℃
本発明例	1	31.8φ×2.0t	0.21	0.18	0.70	0.015	0.004	−	−	0.026	−	−	0.03	0.005	0.0008	65	110	154	○	○
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	16															63	118	151	×	×
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